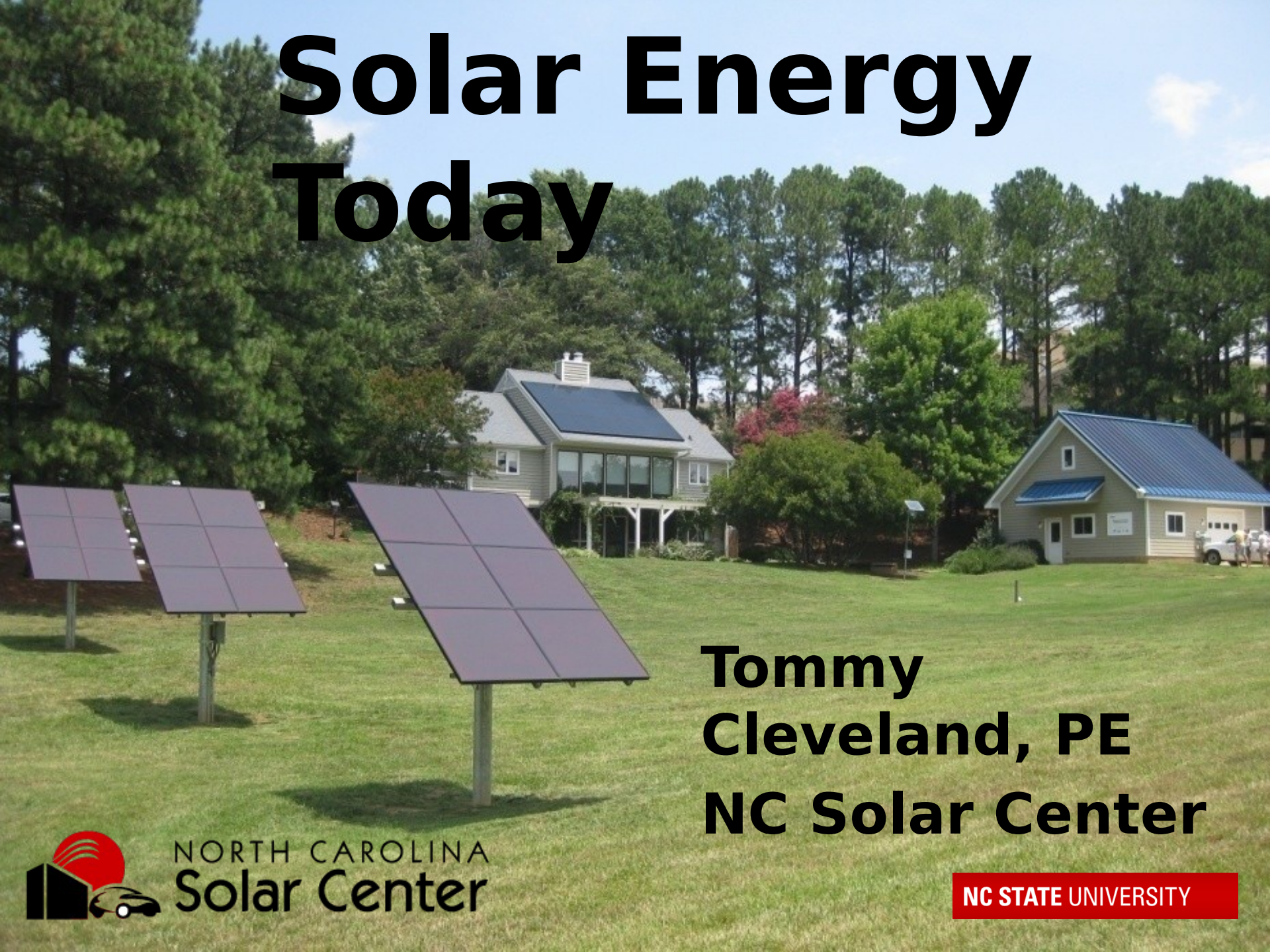
Solar Energy Today



Tommy Cleveland, PE
NC Solar Center

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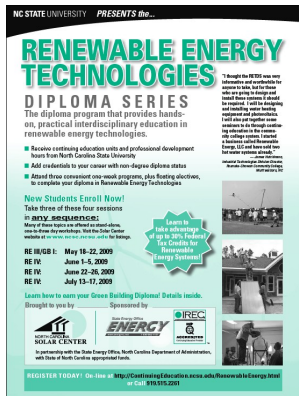
NC Solar Center Program Areas

- Policy Analysis & Outreach
  - DSIRE
- Research & Demonstration
  - Biomass, Solar, Wind, Opportunity Fuels
- Technical Assistance & Training
- Economic Development
- Clean Transportation
- High Performance Buildings
- Education/Outreach
  - Solar House
  - K-16 Education & Outreac
- Distributed Generation Progr

DSIRE
Database of State Incentives for Renewables & Efficiency

SMARTT CHALLENGE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NORTH CAROLINA Wind Working Group

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NC MOBILE CARE
Driving Clean Air & Renewable Energy

NC HealthyBuilt Homes Program

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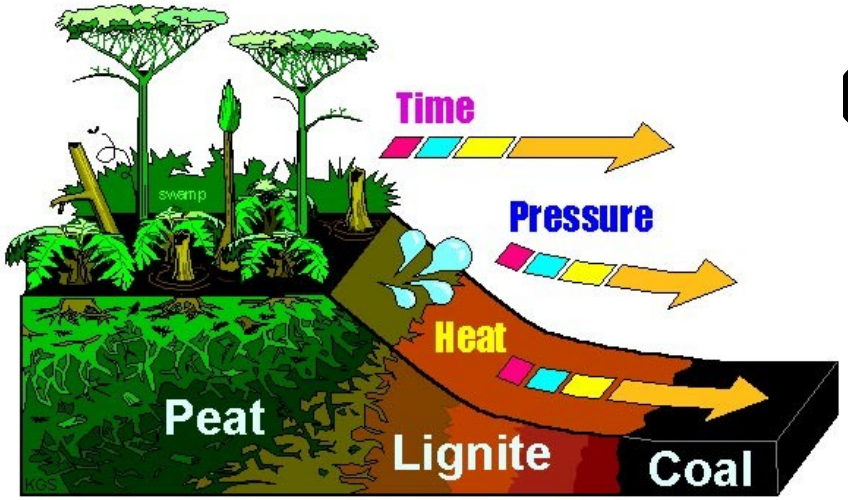
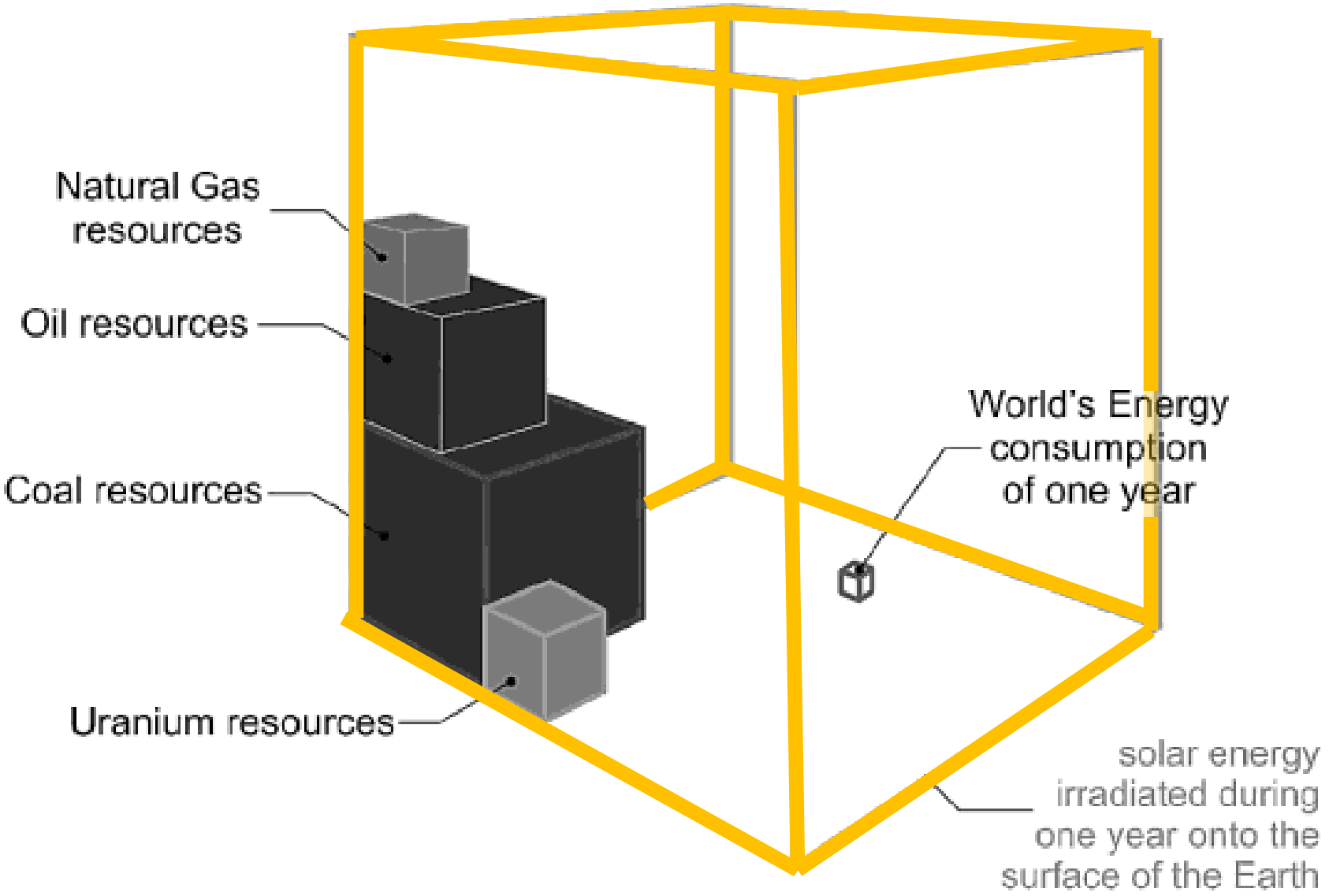
The Fossil Fuel Era – Fueled by Millions of Years of Solar ergy



World Energy Resources


Natural Gas resources
Oil resources
Coal resources
Uranium resources
World's Energy consumption of one year
solar energy irradiated during one year onto the surface of the Earth

-Solar Energy-
Passive Solar – Solar Thermal - PV

Photovoltaics (PV)

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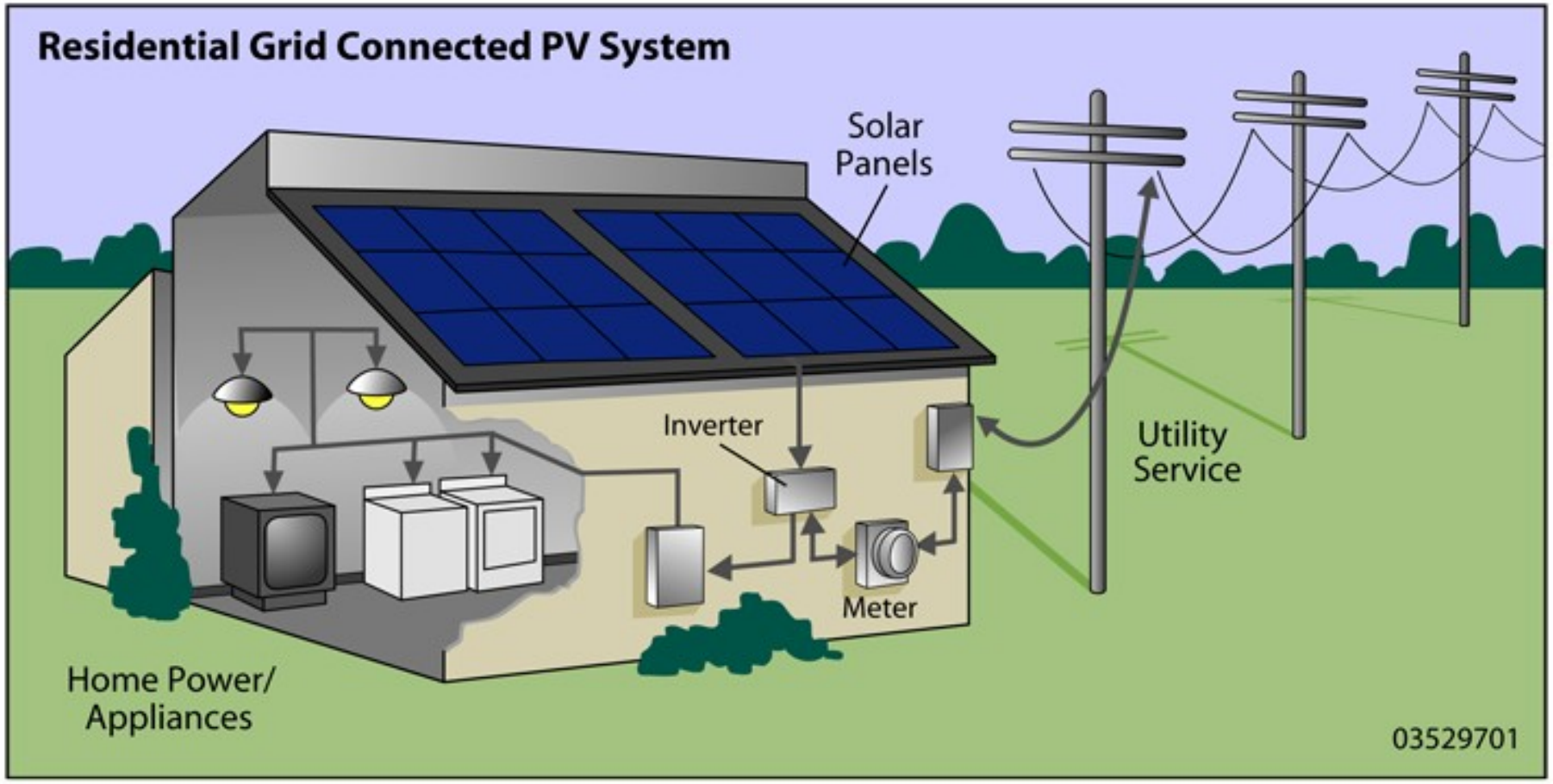
Utility Interactive (Grid-Tied) PV System



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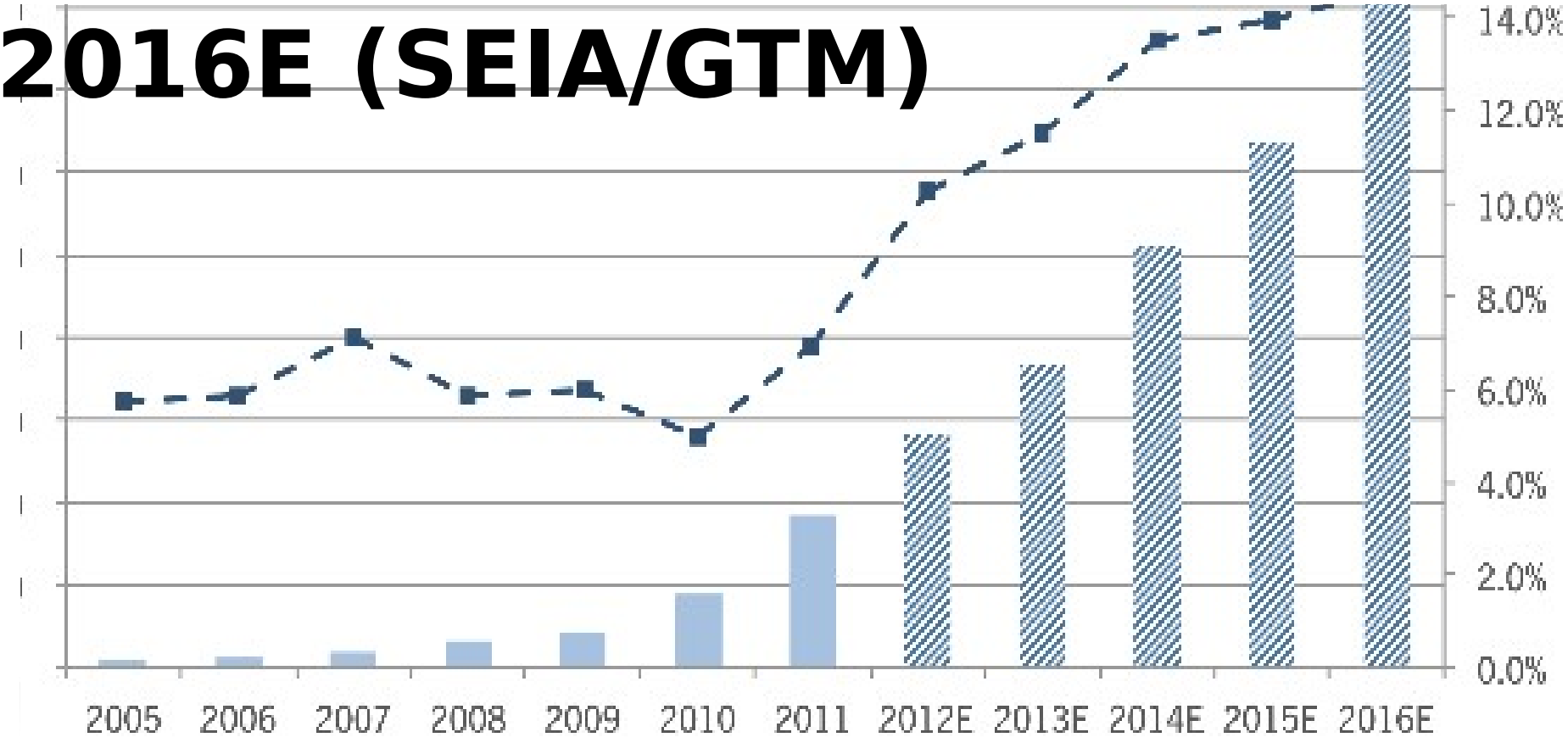
US PV Installations and Global Market Share, 2005-2016E (SEIA/GTM)



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2010-2011 PV Installations by [illegible]

[illegible]	STATE	2010 (MW)	2011 (MW)
1	California	259	542
2	New Jersey	132	313
3	Arizona	63	273
4	New Mexico	43	116
5	Colorado	54	91
6	Pennsylvania	47	88
7	New York	23	60
8	North Carolina	31	55
9	Texas	23	47

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Crystalline Silicon PV Modules

- Over 90% of PV industry
- Mono or poly crystalline PV cells
- Glass front with polymer back in aluminum frame
- 12 to 48 Volts per module
- 60 to 300 Watts per module
- 14% to 22% efficient
- $0.85 to $1.50 per Watt
- ~15W/sq. ft.
- Guaranteed to produce at least 85% of original power in 25 years

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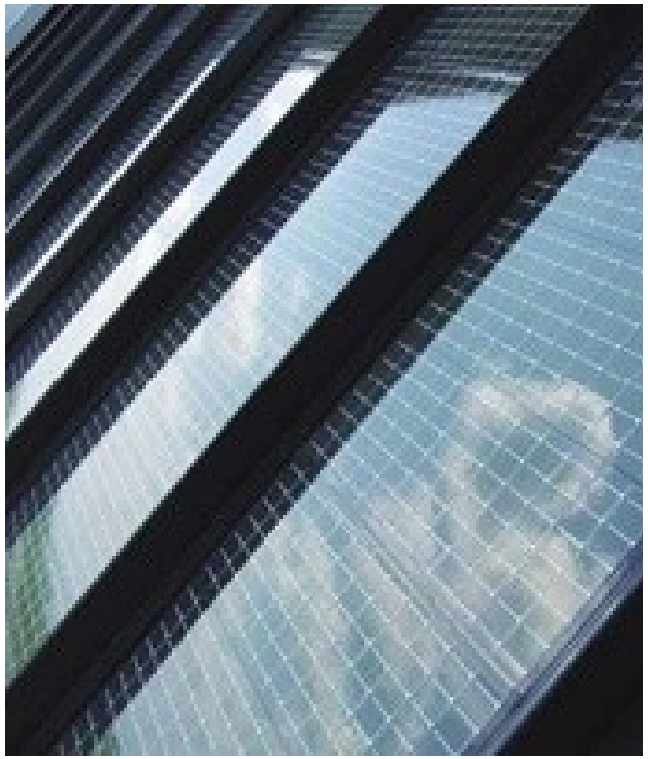
Thin Film PV Modules

- Several technologies in this categories
  - amorphous silicon (a-Si)
  - copper indium gallium diselenide (CIGS)
  - cadmium telluride (CdTe).
- Most have glass front with polymer back in frame, some are frameless
- 8% to 13% efficient
- $0.75 to $1.15 per Watt
- ~10W/sq. ft.
- Most guaranteed to produce at least 85% of original power in 25 years



NC Residential PV System Example

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Photo courtesy of Southern Energy

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NC Commercial PV System Example

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Photo courtesy of Southern Energy

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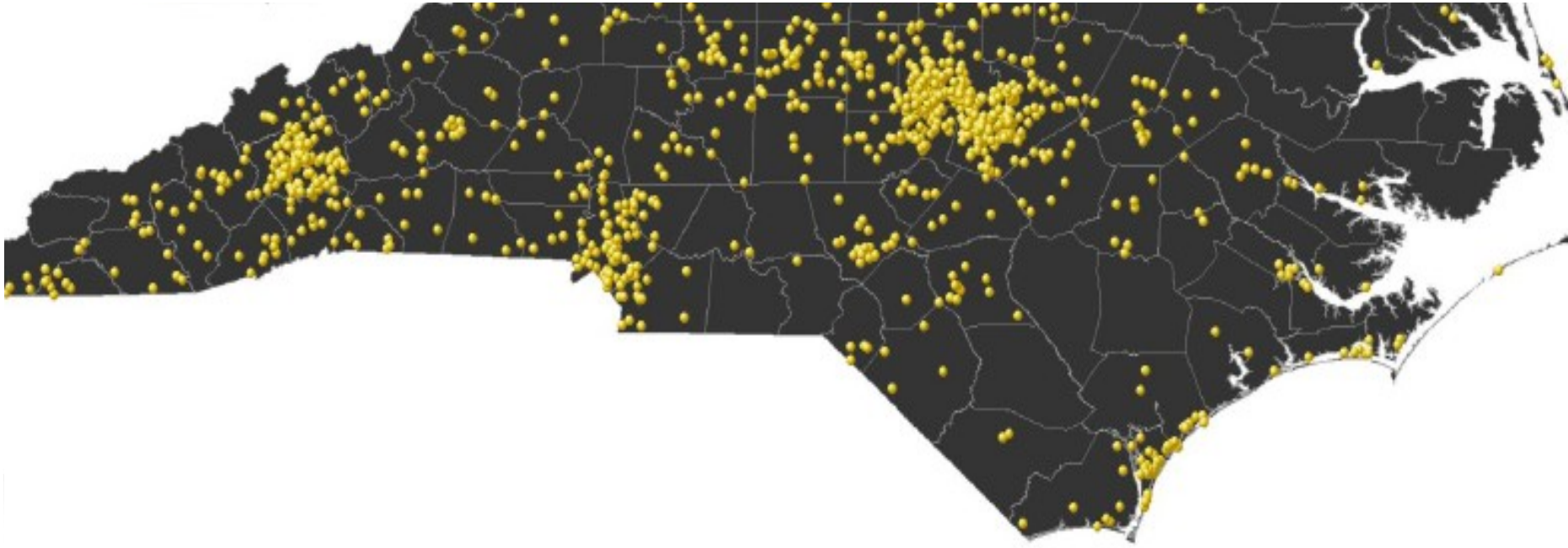
PV Solar Farms – AKA Utility Scale

Example: 16 MW in Davidson, NC

Geographic Distribution of Solar PV Capacity in NC Online from 2006-2011



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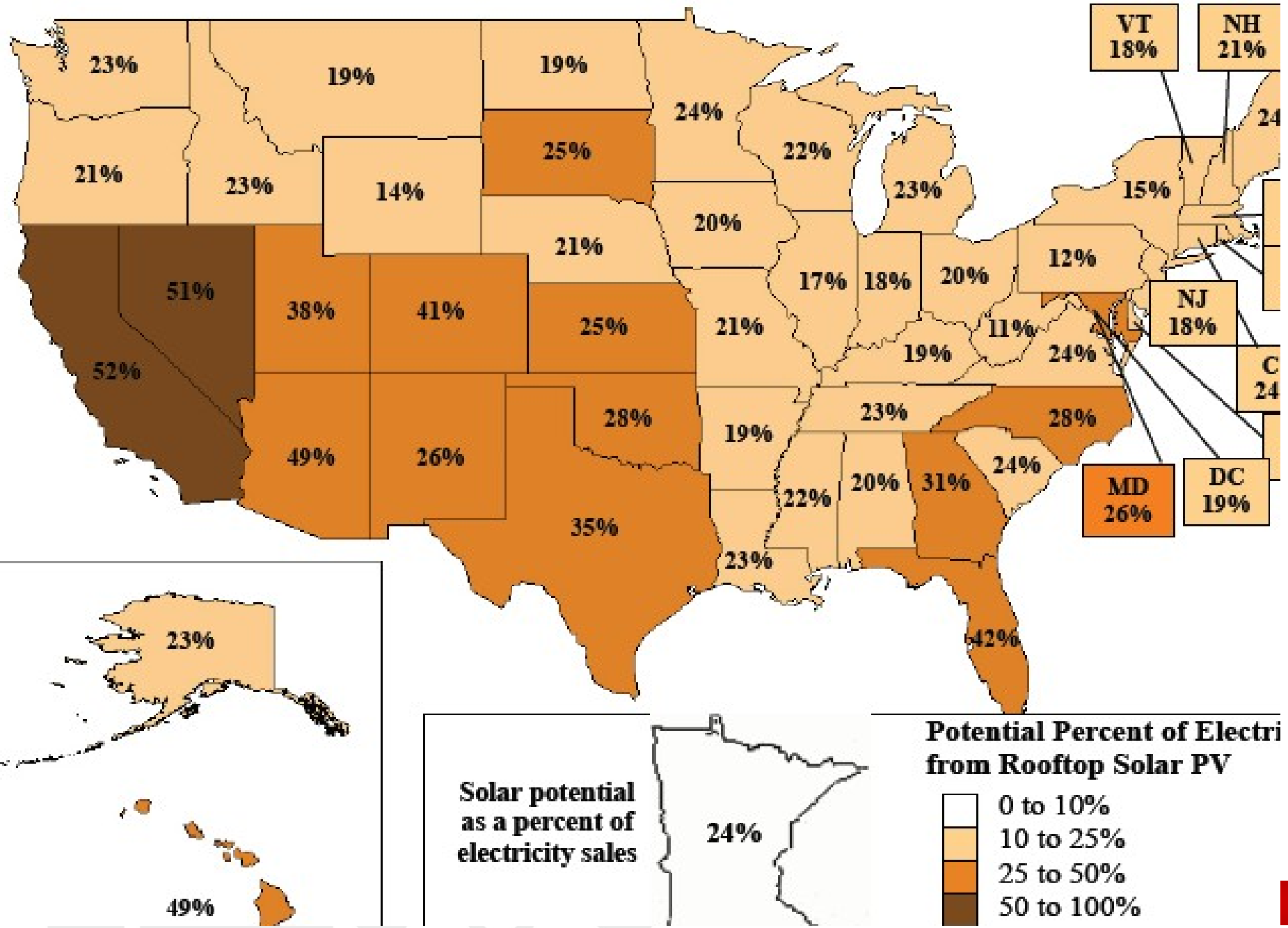
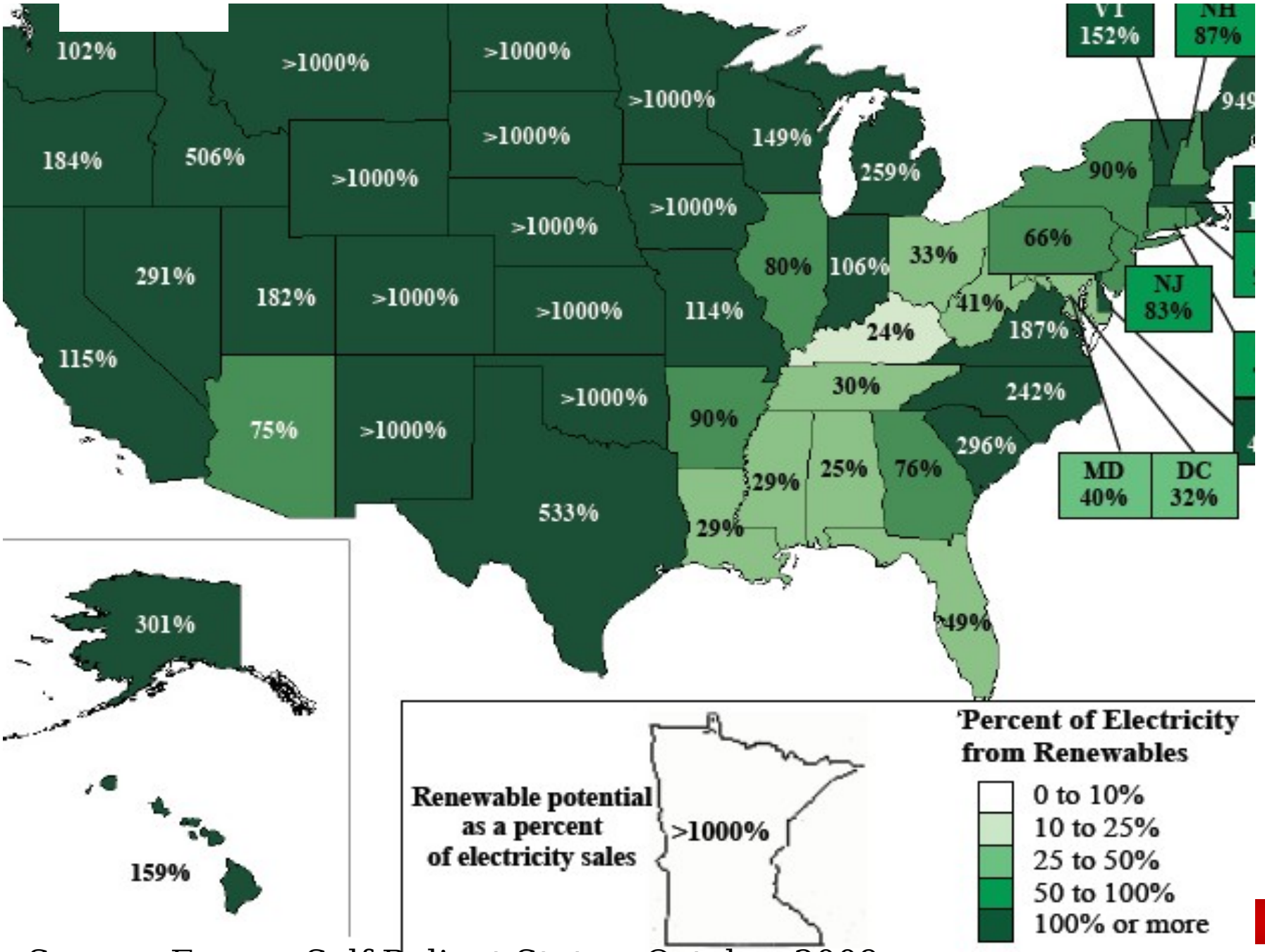
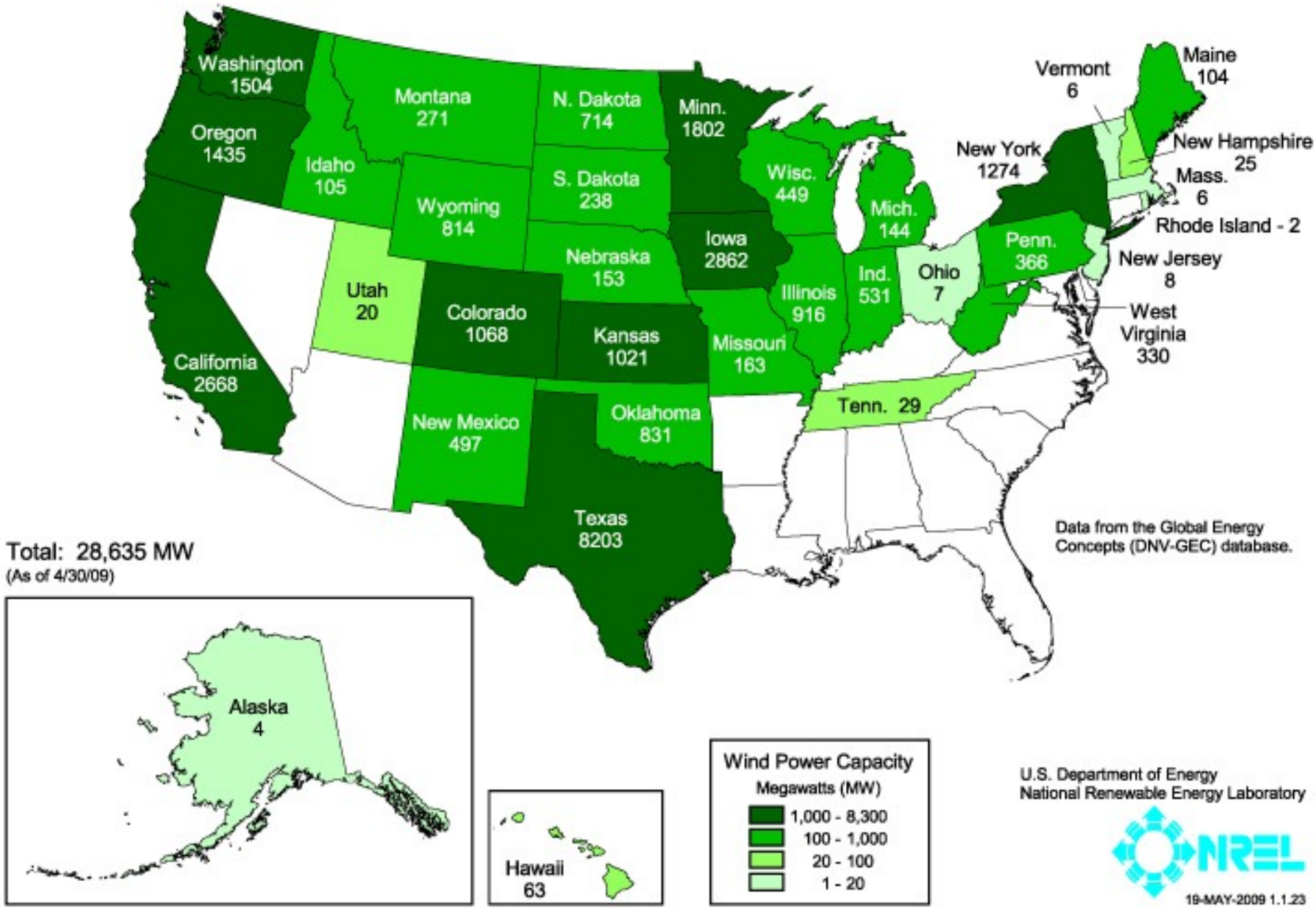


Source: Energy Self-Reliant States, October 2009,


102%
>1000%
>1000%
>1000

Current Installed Wind Power Capacity (MW)



Total: 28,635 MW
(As of 4/30/09)

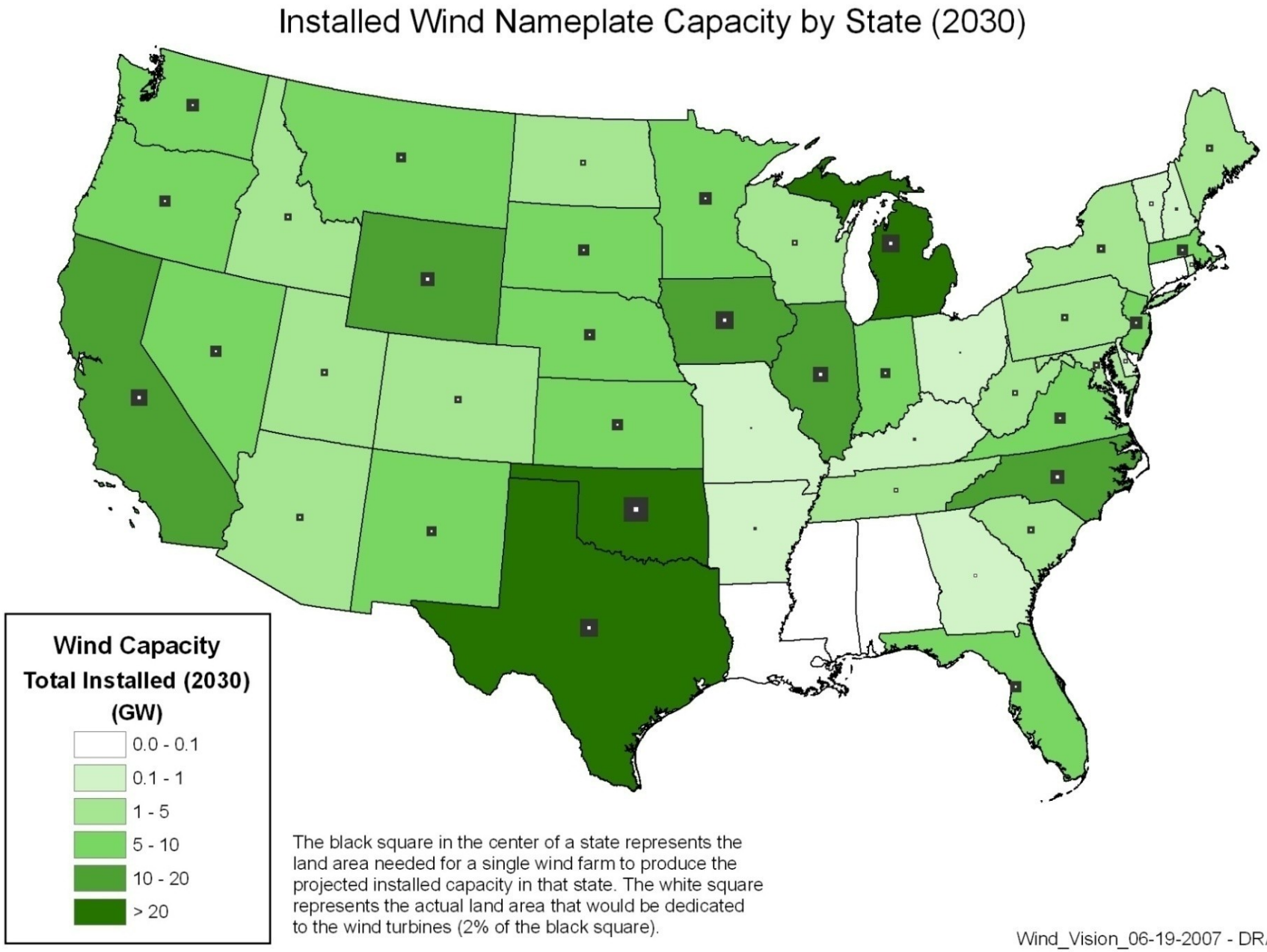
Data from the Global Energy Concepts (DNV-GEC) database.

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

19-MAY-2009 1.1.23

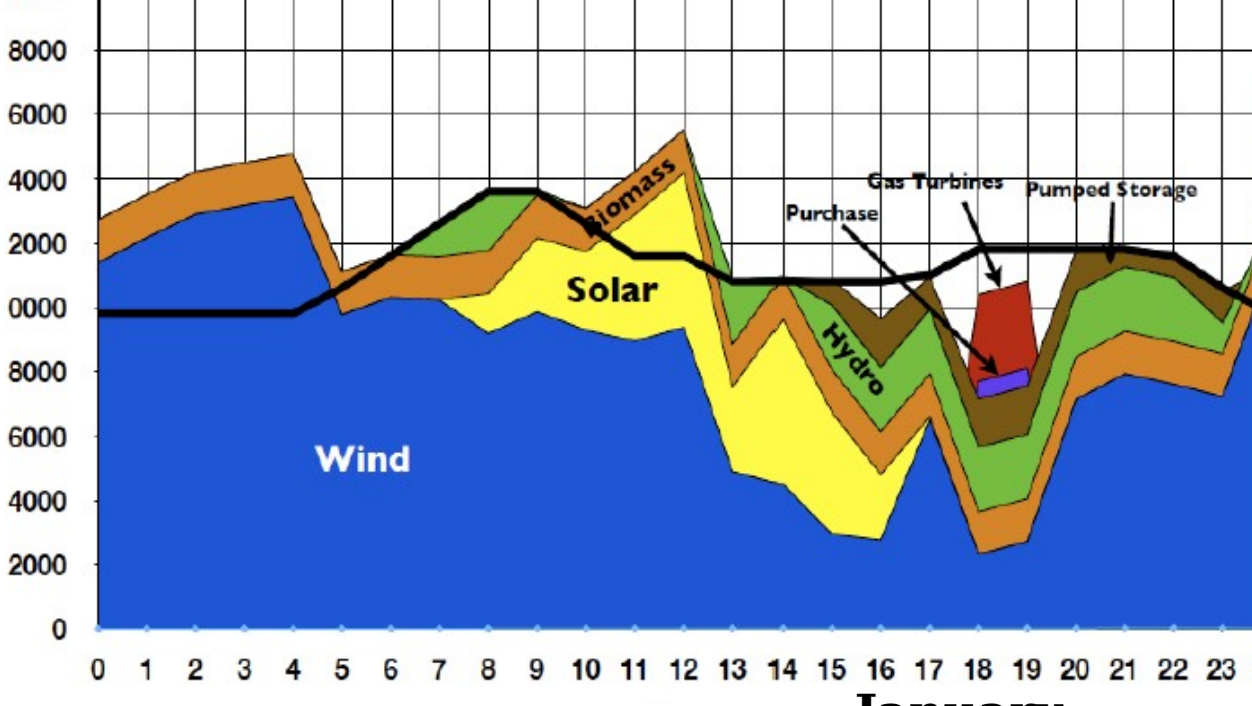
DOE 20% Wind by 2030 Scenario


Installed Wind Nameplate Capacity by State (2030)
Wind Capacity
Total Installed (2030)
(GW)
0.0 - 0.1
0.1 - 1
1 - 5
5 - 10
10 - 20
> 20
The black square in the center of a state represents the land area needed for a single wind farm to produce the projected installed capacity in that state. The white square represents the actual land area that would be dedicated to the wind turbines (2% of the black square).

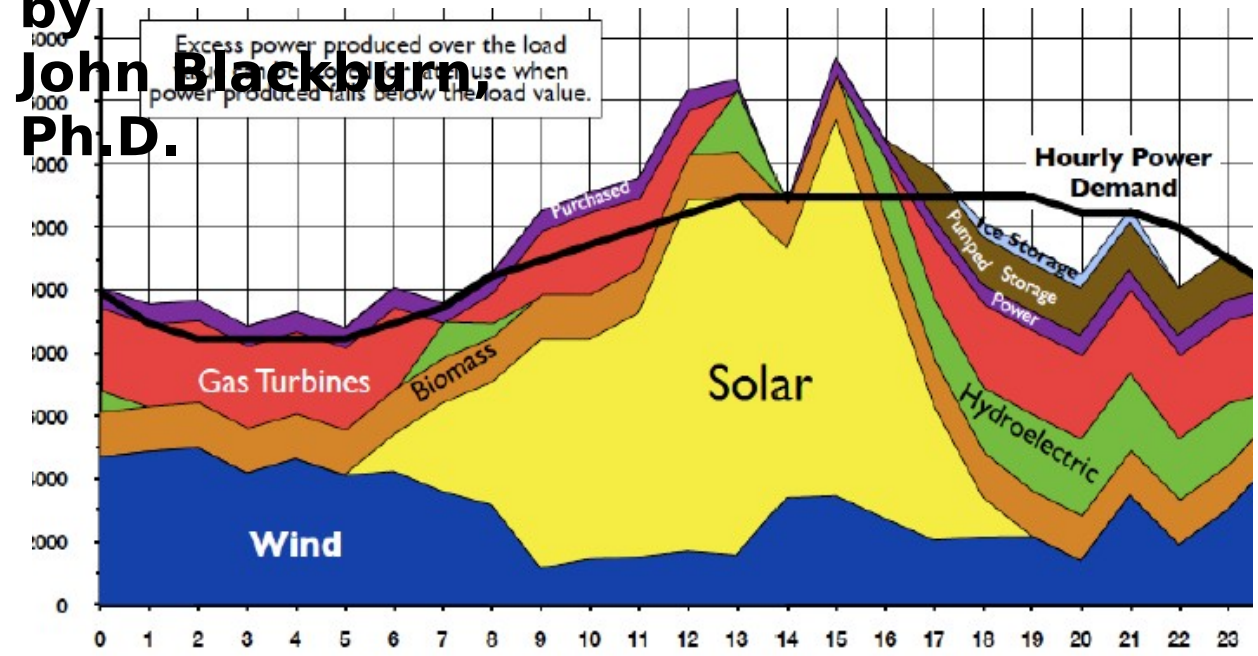
Matching Utility Loads with Solar and Wind Power in North Carolina Dealing with Intermittent Electricity Sources

ww.leer.org/reports/NC-Wind-Solar.pdf

by
John Blackburn, Ph.D.



January Day


Excess power produced over the load
power produced falls below the load value.
Hourly Power Demand
Purchased
Ice Storage
Pumped Storage Power
Gas Turbines
Biomass
Solar
Hydroelectric
Wind
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

-July Day

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Market Innovation

- Micro-Inverters
- DC Optimizers
- Concentrating PV
- Hybrid PV and Thermal
- Labor Reducing Racking
- Financing Innovation
- Soft-cost Streamlining
- Grid Integration/Smart

urtesy SunPower

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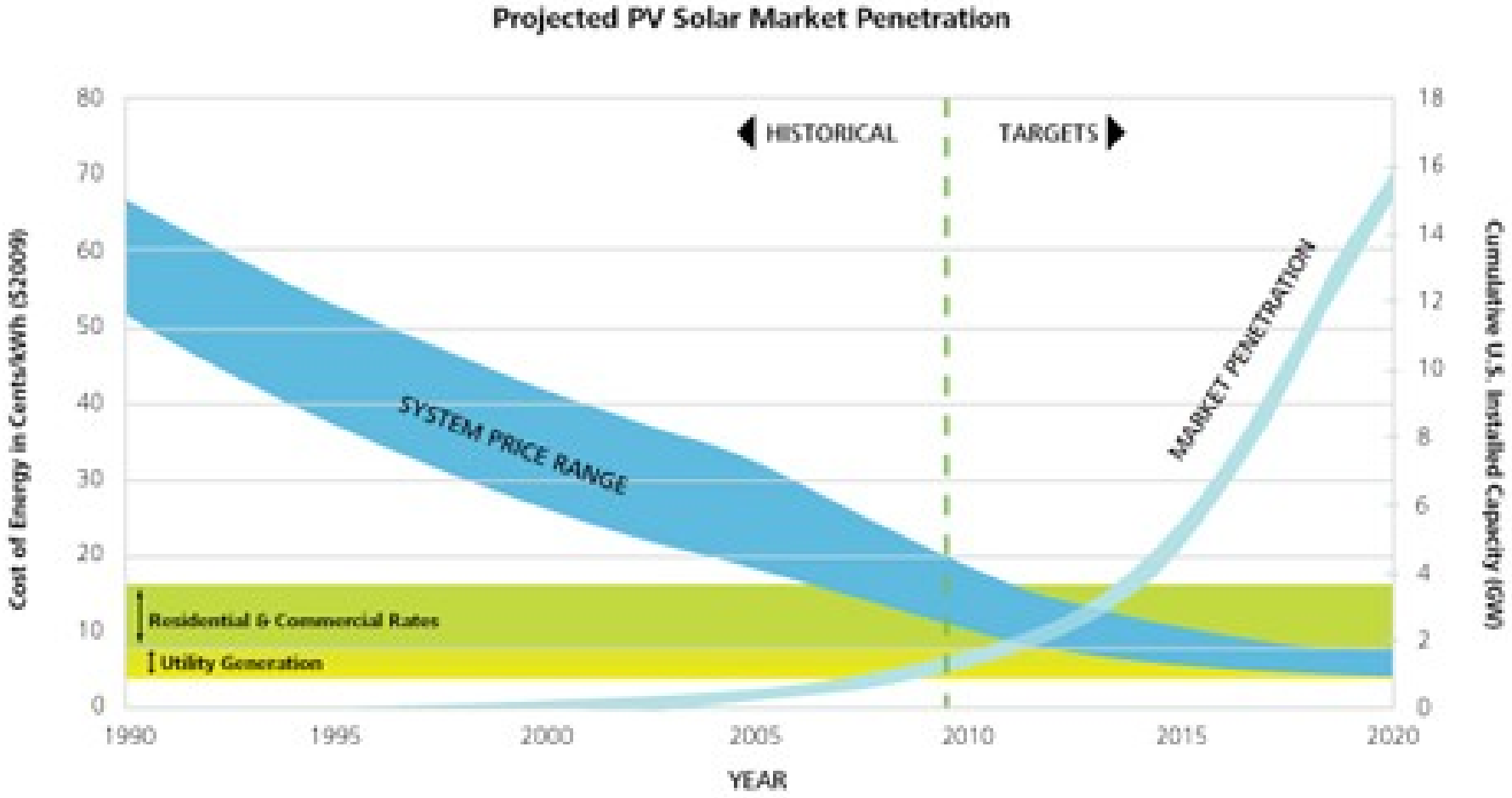
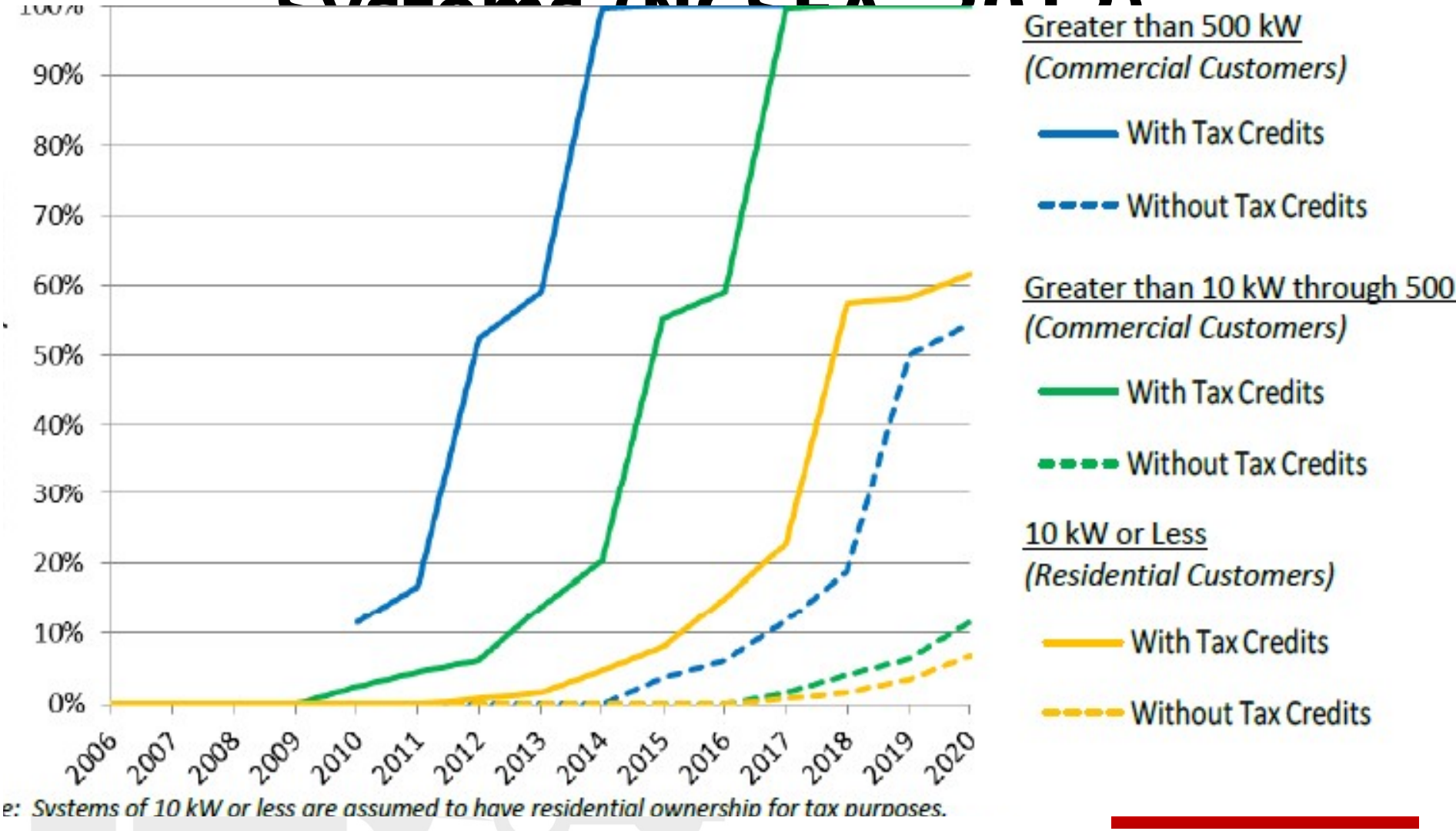
When there is Grid Paritv…



Falling PV system prices will spur a sharp increase in demand from 2010 to 2020

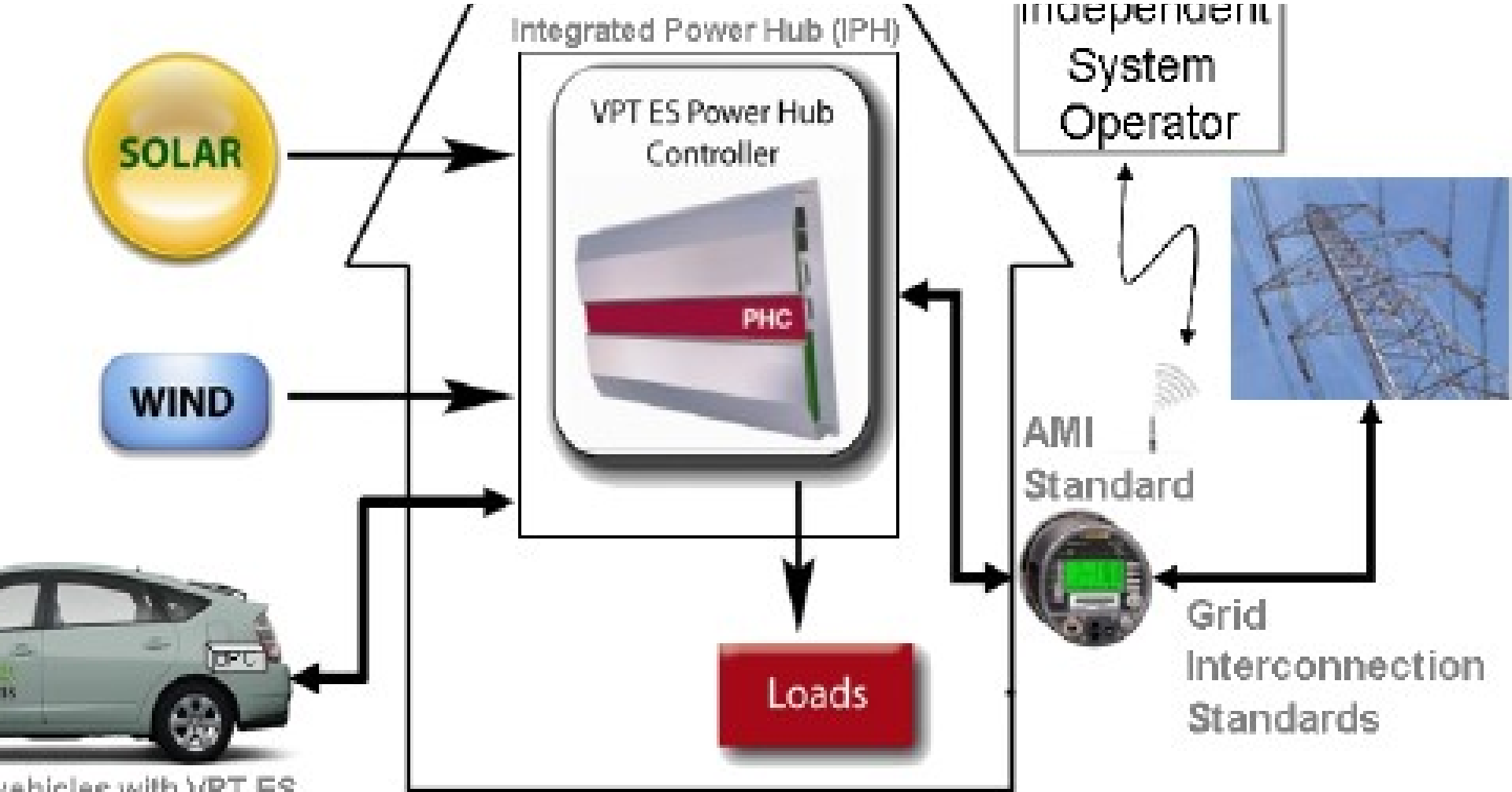
Source: U.S. Department of Energy: Solar Energy Industry Forecast (2008)

Percentage of NC Electric Customers at Grid Parity with LCOE of Solar PV Systems (NCSEA, 2013)



e: Systems of 10 kW or less are assumed to have residential ownership for tax purposes.

Smart Grid and Renewable Energy



Solar Thermal

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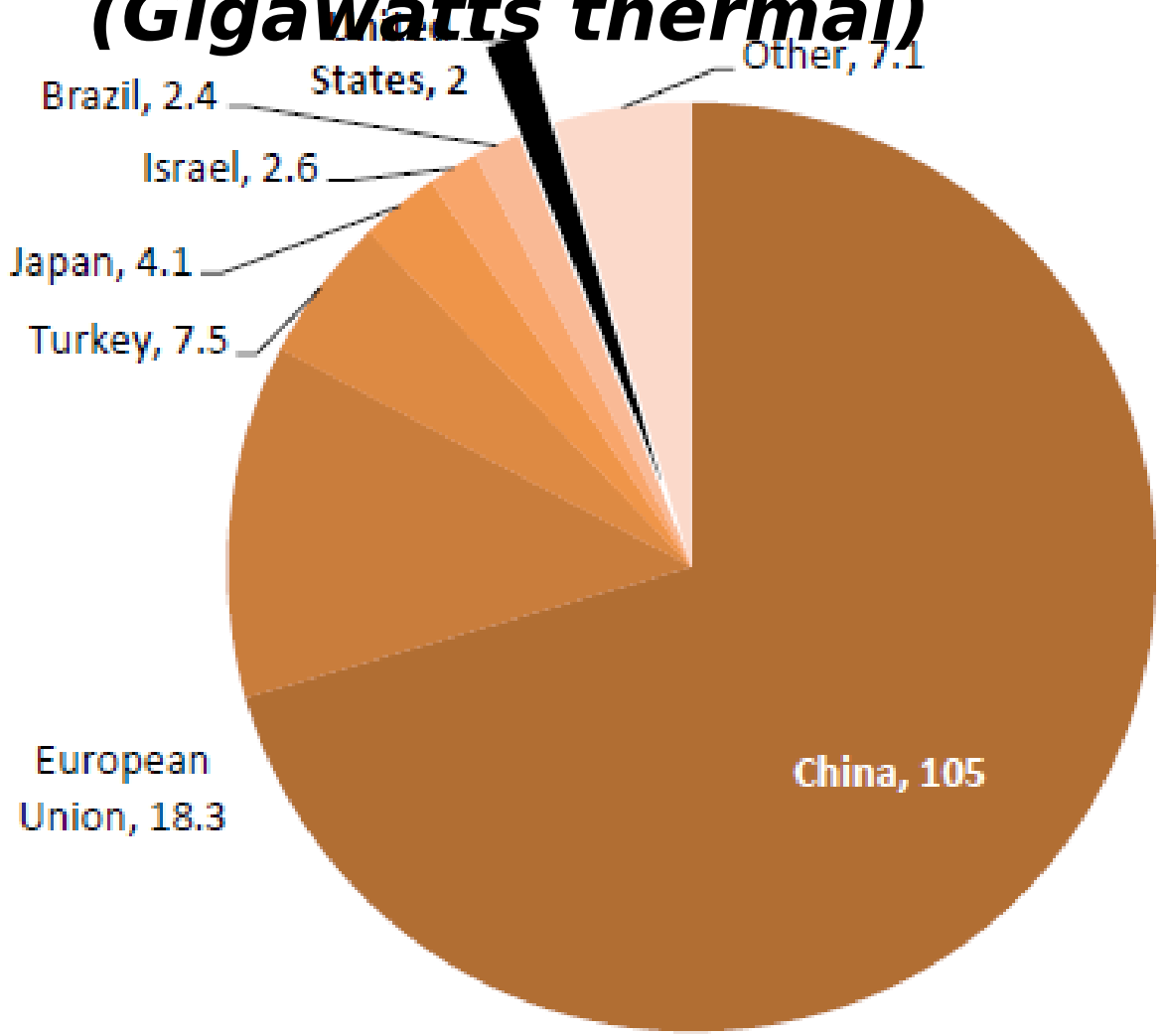
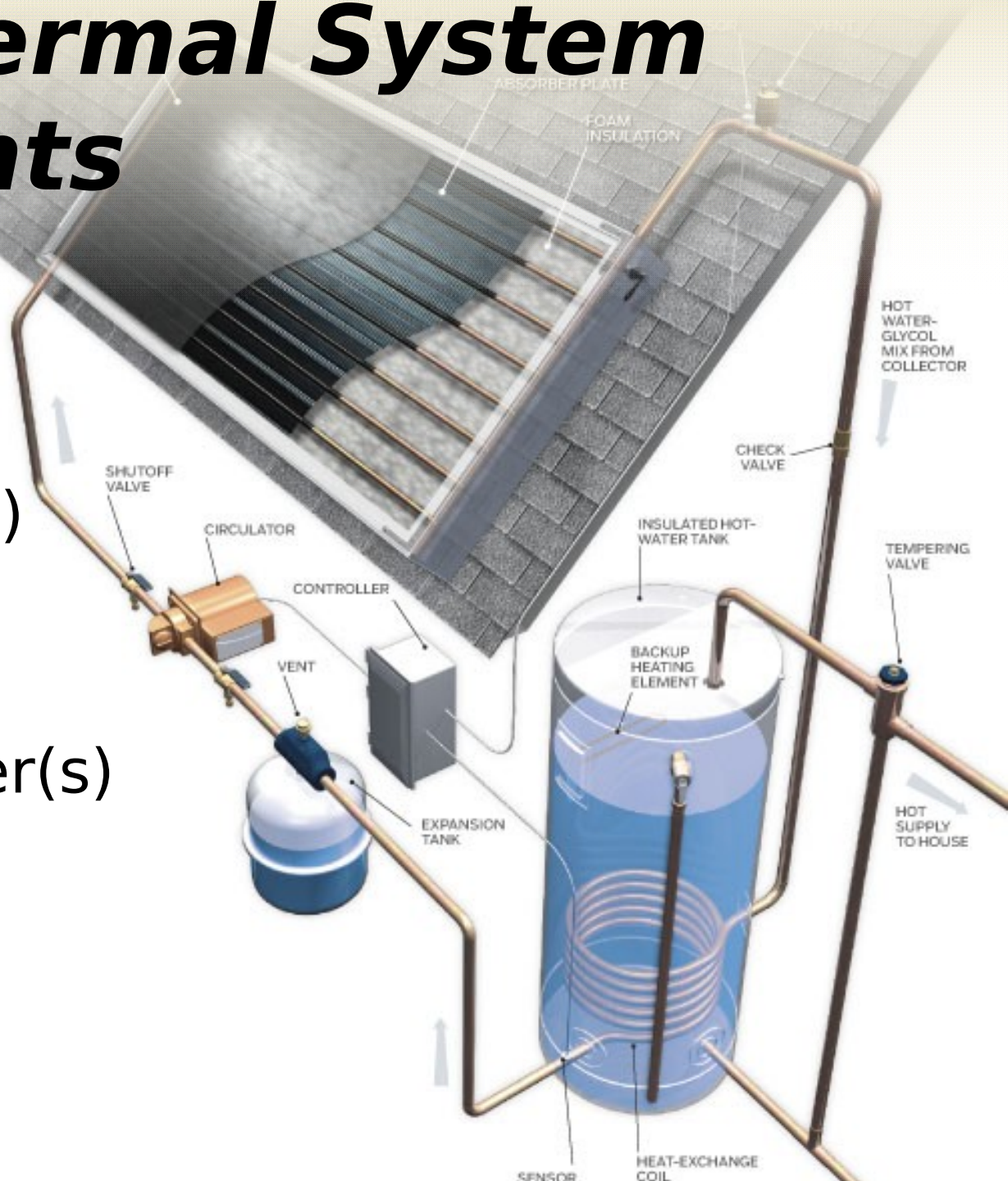
Installed Solar Water Heating Capacity by Country 2008 (Gigawatts thermal)



Solar Thermal System Components

- Collector(s)
- Storage Tank(s)
- Pump(s)
- Controls
- Heat Exchanger(s)



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THEN

NOW

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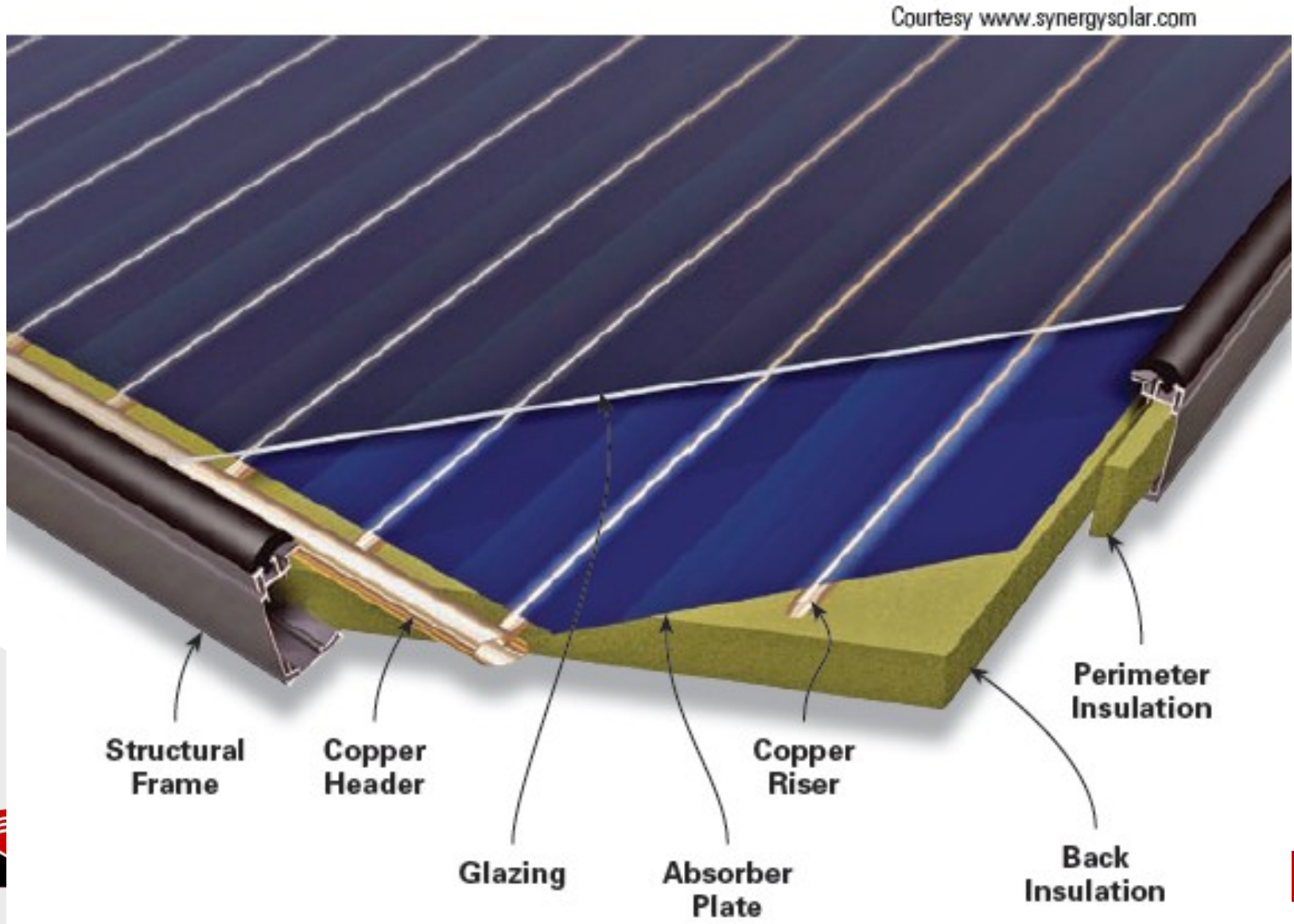
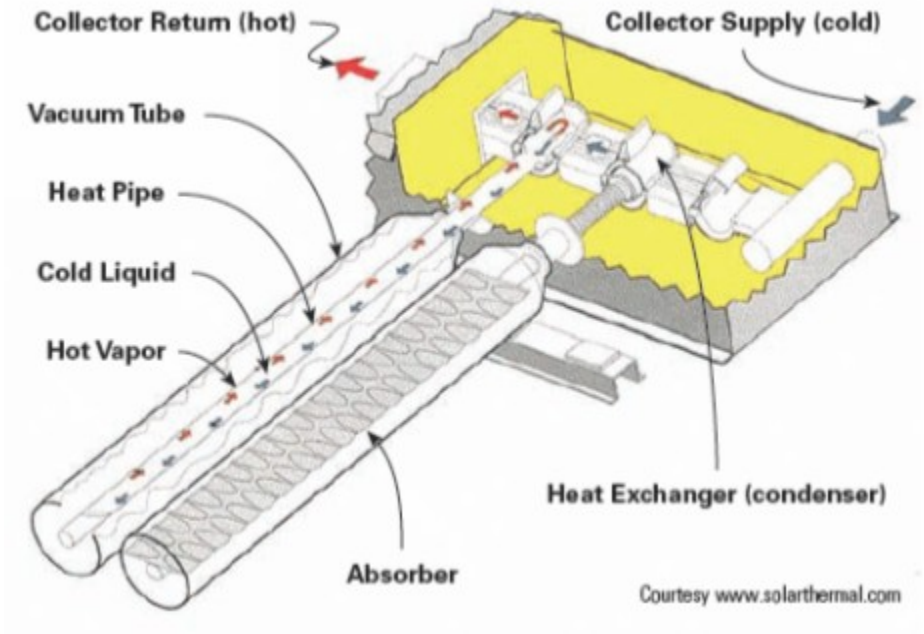
Flat Plate Collector



Evacuated Tube Collector



NC Residential Solar Hot Water System Example

Photo courtesy of Southern Energy

Photos courtesy of Southern Energy Management

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House of Raeford Farms, Rose Hill, NC
Hatchery Facility

Photos courtesy of FLS Energy

The 208 solar panel system

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Nation’s Largest Solar Thermal System is in St. Pauls, NC

- Hot water for Prestage processing plant
- Completed in April 2012
- 7-acre system, 2,100 panels
- Nine x 25,000 gallon solar tanks
- No capital expense from Prestage
- Cost FLS $15 million
- FLS will sell solar energy at lower rate than propane, over 20% savings
- FLS selling RECs

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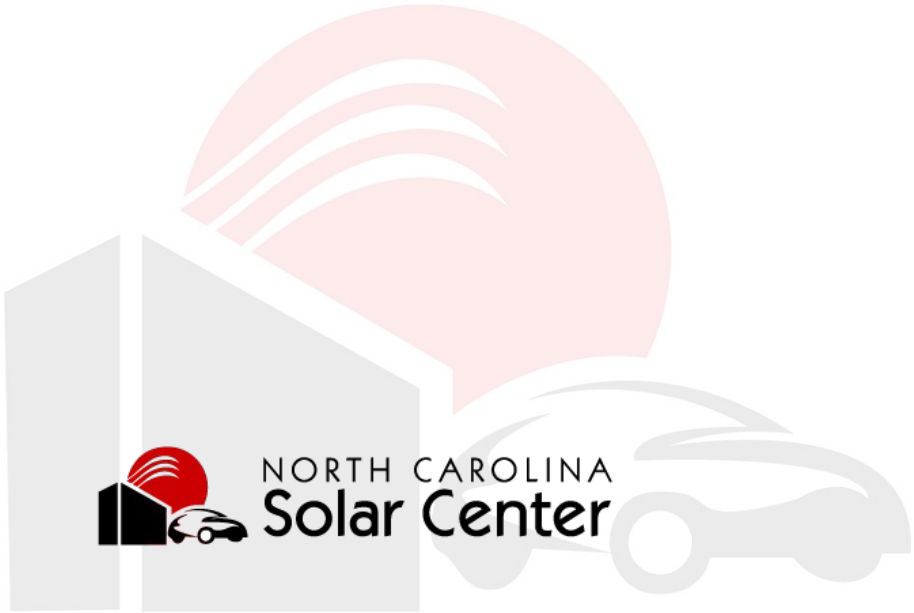
North Carolina Renewable Energy Policies



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NC Renewable and Efficiency Portfolio Standard (REPS)

- **Target Percentages & Applicability**
  - 10% by 2018 – all electric service providers in state
  - 12.5% by 2021 – only investor owned electric utilities (Duke, Progress, & Dominion)

- **Eligible Technologies**
  - Wide range of Renewables, Energy Efficiency, thermal technologies (solar thermal & CHP)
  - IOUs - Up to 25% of REPS from efficiency by 2018; Up to 40% of REPS from efficiency by 2021
  - Coops & Munis - Can meet entire standard (other than Solar, Poultry, & Hog Set Aside) with efficiency

Key Features of NC REPS

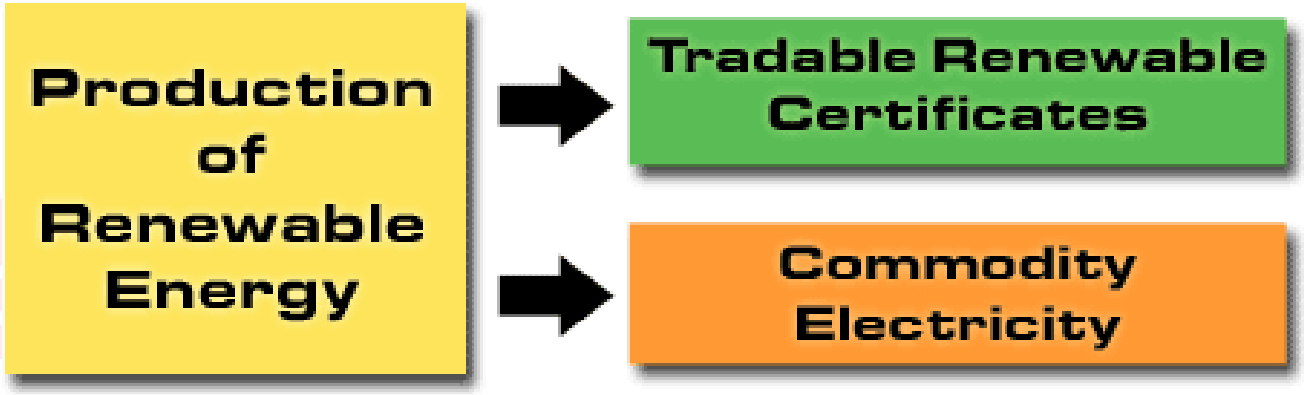
- **Technology tiers**
  - Solar carve-out: 0.2% of retail sales by 2018
  - Hog waste-to-energy carve-out: same as Solar
  - Poultry litter carve-out: 900,000 MWh by 2018
- **Central and customer-sited systems**
- **RECs Tracking System – "NC RETS" www.ncrets.org**

What are RECs?

Renewable Energy Credits

created when a renewable energy facility generates electricity

each unique certificate represents all of the environmental attributes or benefits of a specific quantity of renewable generation



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NC and Federal Renewable Energy Tax Credits

(www.dsireusa.org)

- **NC Credit:**

  35% of full cost, some caps may apply
  Can be taken over 5 years
  Federal income tax (~30%) is owed on the credit received

- **Federal Credit**

  Available through 2016
  30% of full cost, no cap

- **Accelerated Depreciation**

  Full depreciation in 5 years

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NC Grid-Tied Solar Electricity Interconnection Options

- **Buy All / Sell All** – 2 meters
  - NC GreenPower www.ncgreenpower.org
    - Currently paying 10 cents/kWh for <5kW
    - In addition utility pays 'avoided costs' for extra PV ~6 cents/kWh
  - Power Purchase Agreement (PPA) with SRECs
- **Net Metering** – 1 meter turns both ways
  - PV electricity valued at retail kWh rate

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Solar Center USDA Renewable Energy Site Assessments

- USDA Grant covers 75% of cost of renewable energy site assessment for
  - Rural small businesses
  - Agricultural producers
- Includes solar PV, solar thermal, wind, biomass
- Assessment of energy production and economics

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Thank you for your attention

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www.ncsc.ncsu.edu

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